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ABSTRACT

The guide, one in a series of committee reports relating to school band performance, organization, and equipment needs, examines the relationship between microphones and tape recordings. The guide is presented in nine sections. Section I identifies types of microphones (carbon, crystal and ceramic, dynamic, condenser, and ribbon). Section II discusses microphone directional characteristics and designates the cardioid-type microphone as most effective for most musical performances. Section III examines microphone impedence characteristics, followed by discussion of frequency response characteristics in section IV. Section V presents guidelines for achieving the best tape recordings. These include providing a natural front to back perspective, duplicating the tonal balance of the group, and recording from a height above the group. Section VI elaborates general rules about microphone placement. Section VII discusses speed of tape recordings and suggests that music should be recorded at the fastest possible speed. Section VIII describes tape recorder maintenance. The final section assesses types of recording tape and concludes that very little difference exists among name brands of tape, as long as the bias voltage is set for the tape used. (Author/DB)

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Report of the Research Committee on Microphones and Microphone Placement.

AMERICAN SCHOOL BAND DIRECTORS' ASSOCIATION

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AMERICAN SCHOOL BAND DIRECTORS ASSOCIATION

Report of the Audio Visual Research Committee

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AMERICAN SCHOOL BAND DIRECTORS' ASSOCIATION

Report of the Research Committee on

MICROPHONES AND MICROPHONE PLACEMENT

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Today it would be difficult to find a school musical department without a magnetic tape recorder-reproducer. Although this modern day instrument is in a constant state of improvement from a manufacturing standpoint, the microphone which accompanies it is frequently inadequate for faithfully reproducing high fidelity musical sounds. Even the finest tape recorders can reproduce only the sounds which the microphone captures.

The choice of a microphone must be ultimately based on (1) the different types of microphones; (2) their directional characteristics; (3) their impedance characteristics; and (4) their frequency responses. The following will acquaint the reader with these aspects in order that he may be able to better evaluate the type of microphone which best suits his purpose.

MICROPHONE TYPES

1. Carbon Microphones

The oldest and perhaps cheapest of all microphones is the carbon mike. This mike delivers a rather high output voltage and therefore requires very little amplification; its frequency response is rather limited and is quite noisy. Carbon mikes are not suited for high fidelity use but are used in telephones and some types of voice communication where price is an important factor.

2. Crystal and Ceramic Microphones

Crystal mikes are omni-directional and have a rather high output at high impedances - 500,000 to 5,000,000 ohms. This makes it possible to connect the mike directly to the amplifier input without making use of a matching transformer. The high impedance of this mike makes it very susceptible to hum pickups unless a relatively short shielded cable is used (20 to 25 feet).

Ceramic mikes are very similar to drystals in performance and price but they are less susceptible to heat and humidity changes.

3. Dynamic Microphones

The dynamic mike, if well designed and carefully built can provide a very wide and smooth frequency response. It is quite sturdy, is

capable of producing sounds of good quality, and is available at a relatively low cost. These microphones are very versatile. The finest are frequently found in recording studios.

The pick-up pattern of this mike is normally omni-directional, it picks up sound from any direction equally well. But through special design it can be made quite directional and many dynamic mikes on the market have what is called a cardioid pick-up pattern.

One of the more important features of the dynamic mike is its low output impedance which permits much longer mike cables to be used without causing high hum pick-up. This low impedance requires the use of a special step up transformer which is built into some recorders and which must be inserted in the mike cable near the recorder mike in-put where there is no low impedance in-put on the recorder.

4. Condenser Microphones (Also called Capacitor Microphones)

The original condenser mikes were so large that they were not practical for most uses. In the last few years the size has been reduced to the point that one company is making a model 5/7 inches in diameter and six inches long. The condenser mikes being made today approach the ideal in frequency response directionality and dynamic range characteristics covering the entire audio-range with evenness and lack of coloration. Because of these characteristics they are widely used today in professional recording.

Due to the large amount of hand labor required in building this type of mike they are rather expensive ranging in price from around $150.00 to $400.00.

They are more delicate than dynamic microphones and must be handled with care.

5. Ribbon Microphones

Perhaps the cheapest approach to a microphone that compares to a condenser microphone is the ribbon microphone. The sound pick-up consists of a narrow ribbon of corrugated Duralumin supported at its end in a magnetic gap. When the ribbon is caused to vibrate by sound waves, it cuts the magnetic field of the gap and generates a voltage. Since the ribbon mike has no diaphragm or complex suspension system its resonance can be kept below 20 cycles.

These mikes have extremely low out-put impedance and have built-in transformers to match them to the line - usually 600 ohms. Frequency response in the more expensive models is from 20 to 20,000 cps.

The pick-up pattern is bi-directional, sometimes referred to as a figure eight pattern. This pattern is created because the ribbon

generates voltage from only sound waves coming from directly in front or behind the mike. Sounds from the sides have very little if any effect on the mike. This bi-directional pattern has certain advantages - unwanted sounds can be minimized simply by facing the mike in a different direction.

Ribbon microphones are more delicate than dynamic microphones and must be handled with care.

MICROPHONE DIRECTIONAL CHARACTERISTICS

Microphones are manufactured with three basic types of "patterns"——Omni-directional, Cardioid, and Bi-directional (frequently referred to as figure 8). The omni-directional microphone is one which responds to sounds approaching from <u>all</u> directions. It may be satisfactorily used when the volume level program material and extraneous noises can be controlled. The omni-directional mike is sometimes desirable for monaural recording of concerts because it not only picks up the direct sound of the performing group but also the reverberation of the auditorium, which adds life to the recording in the form of "room sound." This type of microphone is most frequently found with non-professional (or "home type" recorders) and where pick-up from all directions (news conferences, interviews, family sings, etc.) is desirable. The performers may stand in a circle around the microphone which records equally well from all directions.

A second type of pickup pattern is that of the Bi-directional, or Figure eight type of microphone. This microphone is somewhat similar to the omni-directional mike except that it is "dead" to sounds approaching from the sides and "live" to those approaching one face or another of the mike ("live" in the shape of the figure 8). One use of such a microphone might be in the center of a pit orchestra, with the dead sides facing the stage and audience. In this way the orchestra on each side would be recorded and the unwanted sounds from the stage and audience rejected. In general, however, this pattern has limited value and should be considered only for special applications.

The <u>most effective</u> type of pickup pattern for most musical peformances is that of the Cardioid or Uni-directional microphone which has a response pattern which closely resembles the shape of a heart. This microphone accepts that sound which approaches it from the front, but tends to reject that which approaches from the sides and rear. It is preferred where the reverberation period is very long and/or where there is a high level of unwanted background sounds (room reverberation, audience coughs, etc.). Further it is desirable for stereo recording where directionality is needed to create the stereo effect of left and right.

MICROPHONE IMPEDANCE CHARACTERISTICS

For the purpose of this report, the reader need only understand that microphones and tape recorders are manufactured with high and low impedance inputs and outputs. A technical discussion on this topic might give the reader a clearer understanding of the meaning of the subject, but would contribute little to his ability to utilize the equipment under actual recording circumstances, which is the real purpose of this report.

A high impedance microphone has a short mike cord (probably not longer than 20 to 25 feet). To increase this length would mean the probability of (a) adding a low frequency hum on the recorded tape and (b) to incur a certain amount of high frequency loss (for example this is 16 db at 10,000 Hz when using 100 feet of microphone cable between the mike and the recorder). Otherwise there is no basic difficulty with using a microphone of this type.

A low impedance microphone may have up to 1,000 feet of microphone cable between the mike and the recorder without being subject to hum and high frequency loss on the tape. This is a most desirable situation when the recordist wishes to have the microphone fifty or more feet from the tape recorder.

A high impedance mike must be matched to a high impedance input to the tape recorder. Likewise a low impedance microphone must be matched to a low impedance input to the recorder. Otherwise there will be a loss of volume and distortion in the frequency response of the sounds passing from the microphone to the tape recorder.

Most of the tape recorders designed for use by amateur (or non-professional applications) will be designed for high impedance microphones. Occasionally these recorders contain a switch which will enable the recordist to change the input from high to low impedance, thus accommodating either type of microphone. However, a low impedance mike may be used with a high impedance recorder input with the addition of a matching line transformer connected to the line cord between the mike and the recorder. This may be added to the mike cable by either the mike manufacturer (AKG Company furnishes low impedance microphones with built-in high impedance transformers for just such a purpose), or by a local tape recorder service establishment if the recordist does not feel capable of wiring the transformer himself.

If the reader's tape recorder has a high impedance input (20,000 ohms or higher as listed in the machine's specifications), he may wish to consider the versatility afforded him by the longer microphone cable with the low impedance mike (50 to 250 ohms) and a matching transformer. The cost would be less than $20.00 for the addition. All professional recorders and mikes are of this low impedance type.

FREQUENCY RESPONSE CHARACTERISTICS

The frequency response of a microphone used for recording music should be very broad (at least 40-15,000 Hz). However, unless the conditions under which the recordings are being made are ideal, many unwanted sounds in the bass region may be picked up from air conditioning units, street traffic rumble, etc. Therefore, a microphone whose response falls of at about 50 Hz will many times prove more satisfactory for school recording than a mike with even response down to 30 Hz.

It may be seen from the above explanations that in selecting a microphone many things must be considered. No one characteristic alone should determine which mike should be chosen. The reader should keep in mind where and how the microphone is to be used and the equipment with which it is to be combined. In general, it is recommended that the microphone be of a low impedance, dynamic or condenser type, with preferably a cardioid pattern for best general recording under classroom and concert hall conditions.

GUIDELINES FOR ACHIEVING THE BEST TAPE RECORDINGS

A good tape recording should duplicate the dynamic range of the group. To achieve this the recordist should make preliminary test recordings of the group's softest and loudest musical passages in order to ascertain one basic record volume setting which will record both volume extremes without (1) producing distortion (resulting from recording at too high a volume level for the tape recorder) and (2) changing the volume setting during the course of the recording. He should plan to record at the loudest volume possible without producing distortion. For instrumental groups this would mean recording with a VU meter setting for the loudest volume passages at between 0 and +2. Distortion frequently occurs on choral recordings when volumes reach these heights. Experimentation will possibly demonstrate that lower peak volume readings of -1 on the VU meter will produce recordings free of distortion.

A good tape recording will represent the musical group in good perspective--a natural front to back perspective while preserving the relative size of the group from side to side. This may not be possible in the limited size of the school music room, due to the close proximity of the group to the microphone and the limited ceiling height of the room. However, in a large room (or auditorium) the front row should <u>not</u> sound overly bright (and close) while the back row sound miles away!

A good tape recording has a well-defined sound. This is related to the distance the microphone is located from the performing group. It also bears some relation to the condition and type of tape recorder, microphone, and magnetic tape used. For the purpose of discussion here, the writer will consider only the matter of microphone placement. The farther the microphone is placed from the group the more distant will be the recorded sound

reproduced. It is less distinct (due to the addition of room reverberation), less brilliant (highest frequency sounds are lost as the recorded distance increases), and the overall sound becomes increasingly "muddy" and "boomy."

A good tape recording should duplicate the tonal balance of the group. The sections of the choir or band should remain in good internal balance (if the group indeed performs this way). Even the finest microphone "listens objectively" not subjectively as do a listener's ears. If one section is louder then the recording will point this out. If, however, the group is playing with acceptable internal balance, then the reproduction of this balance is a function of microphone placement--far enough away from all sections to create the effect of this balance.

A good tape recording should create the illusion of a group performing in a pleasant sounding concert hall. While this is probably not possible in the music room, a recording made in the school auditorium should be made from a height above the group and distance from it so as to create this illusion (which is a combination of all four points discussed above).

SOME GENERAL RULES ABOUT MICROPHONE PLACEMENT

The microphone should always be placed as far back (or as high above) as possible but no further than necessary to be able to capture a good blend and the apparent size of the group. It is this writer's opinion that it is better to have the microphones a bit too close than to have them too far away. Microphones are placed too close when (1) the individual voices and/or instruments become noticeable or (2) when the sound of the group begins to take on a harsh, strident quality.

HOW MICROPHONES "HEAR"

There are significant differences in microphones, depending on their directional patterns (omnidirectional, cardioid, or figure 8), background rejection characteristics designed by the microphone manufacturers, and frequency response characteristics (which are <u>different</u> when the sound source strikes the microphone from directly in front, i.e., perpendicular to the face of the mike diaphragm, than when it strikes the microphone "off-axis" or from the side of the microphone.

If a microphone is placed in front of the <u>middle</u> of a musical group, the sound emanating from the <u>middle</u> portion of the group (and striking the microphone straight ahead) will be noticeably louder than the sound approaching the side of the mike from the group's outer edges. The same holds true of the microphone is placed <u>in front of and above</u> the heads of the group. In this case the sound coming from the singers (or players) directly in front of the microphone diaphragm will be that sound coming from the rear portion of the ensemble, since the front of the group is closer but <u>off to the side and below</u> the microphone.

In general it may be said that the closer the microphone is placed to a group the higher it must be placed. It must be raised so as to point directly toward the rear of the group (the "on-axis" sound will appear louder), making the first rows appear to have less volume ("off-axis" because they are to the side and below the mike). In this way the closest performers will maintain a musical balance and perspective with the sides of the group and the furthermost players in the rear. These two sounds tend to balance each other (with correct mike placement) and provide a close, brilliant, yet satisfactorily balanced recording.

By moving the microphone back (away from the group) and lower, the same basic type of balance will be maintained, except that the loss of high frequency sounds will make the sound more distant and mellow, and the sound will become less distinct (muddy) and possibly boomy in a very reverberant hall.

A combination of both types of recorded sound is desirable, depending on the needs and desires of the recordist. Clarity and definition of sound should be preserved, while muddy, distant sounds should be avoided. However, miking should not be so close as to reveal individual players' sounds or to destroy the blend of an ensemble sound.

MICROPHONE PLACEMENT

While the forgoing explanations are valid in terms of generalizations, in practice the actual positioning of microphones will depend on the following:

1. The wishes of the recordist and what he wants to hear.
2. The recording equipment and playback equipment used to listen to the tapes.
3. The size and acoustical envronment of the recording area.
4. The size and excellence of the musical group and the relative balance achieved between the groups individual sections. Excellent musical groups are easier to record, sound better, and may be miked closer than mediocre or poor ones.

The following are suggestions for actual microphone placement. The recordist should realize that this is the most important aspect of capturing a reasonably accurate illusion of the actual musical performance. The microphone "listens" objectively and in the same manner whereever it is placed. The recordist must decide where to place it to produce the type of sound which he (the recordist) wishes to reproduce. The practical experience of microphone placement along with the musical training of the recordist are two vitally important fundamentals which need to be combined in a process of decision making which will ultimately result in the microphone's being placed in the position where it will capture the group's sounds in a musically pleasing manner.

This explanation will be concerned with two microphone stereophonic recording only. The principle of monaural recording is roughly the same except that the mike placement must be a bit farther away from the group for best overall balance. The addition of microphones beyond a basic two (a minimum for stereo miking) would be for the purpose of highlighting certain sections, soloists, capturing background room sound, etc. and is concerned with a series of variables far beyond the scope of this report.

1. Instrumental Groups

If the group is not on risers, place two microphones (in cardioid position) 10 to 12 feet back from the group and at least 8 to 10 feet above the floor on which the group is seated (reverse these figures if the group is on risers). The microphones should be pointed down into the center or slightly back of center of the group, about 6 to 8 feet apart, and angled outward slightly (depending on the width of the group). These distances and heights will vary with room conditions, and for groups on risers whose front to rear depth is greater or narrower.

2. Choruses

Begin by placing two microphones (in cardioid position) 10 to 12 feet back from the group, with the microphones slightly higher than the head of the tallest person in the group. They should be pointed down into the center of the group, angled outward slightly (depending on the width of the group), and be approximately 6 to 8 feet apart. These distances and heights will vary with room conditions, and for groups on risers whose front to rear depth is greater or narrower. Frequently choral groups perform with a piano placed in the center of the stage, a condition which is almost impossible to mike effectively, since the piano is closer, frequently louder than the voices. Using the above principles, higher and closer miking may help solve the problem. Occasionally moving the mikes farther apart will also reduce the amount of piano sound captured by both microphones.

At this point the recordist should let his ears be his guide for microphone adjustment. He may wish to move the mikes closer for "live" rooms or farther back if recording in "dead" rooms, etc., etc. He may wish to achieve greater stereo separation by moving the microphones farther apart. However, he should be careful not to leave a "hole in the middle" of the sound by having the microphones extremely far apart, since even the finest concert type of stereo recordings should have some feeling or illusion of common sound material in the middle. Extremely wide miking will provide two definite sound sources, left and right, but will sound unrealistic when compared to the actual performance of the group from the listener's seat in the auditorium.

SPEED OF TAPE RECORDING

It is desirable to record music at the fastest possible tape speed. 15 inches per second (commonly referred to as ips) is the professional speed and should be utilized whenever possible. It has many advantages over the slower recording speeds. 7 1/2 ips is a workable speed, but 3 3/4 ips speed

should be avoided whenever possible, despite recommendations of manufacturers as to the relative merits of this speed with certain tape types and record processes. The fact remains that the higher the speed of the tape the safer the recording. If a public performance is to be recorded there is no opportunity to rerecord it because of tape saturation and distortion.

TAPE RECORDER MAINTENANCE

No report of this nature could be complete without a brief section devoted to the tape recorder and the tape used, since these are the tools be which the recordist will measure the results of his microphone purchase and the ultimate placement. Without proper maintenance, clean tape heads, and reliable tape, the finest microphone will appear to be second best.

Tape recorder maintenance is a continuing process. It is recommended that the serious recordist follow these simple guidelines for more trouble free recording.

A. Have the recorder checked annually by a competent repairman.

B. Clean all parts touching the moving tape and keep them clean.

1. Rubber pinch roller and plastic parts - use isopropyl or grain alcohol. Regular rubbing alcohol leaves a residue.

2. Tape heads and tape guides - use alcohol or fluid recommended by manufacturer. Beware of carbon tetrachloride or regular cleaning fluid. It may destroy the plastic laminations which are part of the record and playback heads of certain recorders.

C. Demagnetize tape heads, tape guides, and all metal parts touching moving tape every 5 to 10 hours. The most expensive demagnetizer (Ampex) costs no more than $10.00. It is well worth it.

D. Automatic de-gaussers (demagnetizers) do not do the complete job as advertised by the manufacturers.

E. Replace pressure pads which hold the moving tape against the record and playback heads when they become worn.

SUGGESTIONS ON TYPES OF RECORDING TAPE

1. Mylar (polyester) vs. acetate.

Both are satisfactory but this writer prefers mylar because of its durability and stability as a backing material for the oxide. It is a bit more difficult to work with than acetate and if it does stretch, the tape is ruined. However, acetate also stretches before it breaks and the splice necessary to put the tape back together may also be heard.

2. What thickness of tape should you use?

1/5 mil; 1.0 mil; 1/2 mil (standard or tensilized) are available to today's recordist. The best tape from thestandpoint of durability, lack of flutter, and lack of tape saturation is the thickest tape, i.e. 1.5 mil. The thinner tape may not wrap itself around the record head properly (causing momentary tape dropouts). Moreover, the thinner tapes cannot be as firmly grasped between the capstan idler and the rubber pinch roller. The result is an increase in flutter characteristics of the recorded sound.

3. Bargain or white box tape?

This is no bargain because (1) it will cause increased head wear over a period of time and (2) will have occasional defective sections which may ruin the reproduction of a very fine performance. It is tape which is <u>not</u> quality controlled. The serious recordist should not wish to save a few dollars on tape which has been rejected because it would not meet manufacturing quality standards.

4. Which brand of tape should you purchase?

A major hi-fi magazine tested many of the "name" brands of tape for quality. The findings were that there is very little difference between them so long as the bias voltage is correctly set for the particular tape used. Since the average recordist cannot change the setting on non-professional tape recorders, he should choose the tape which sounds best on his recorder (all major "name" brand tapes will sound slightly different) and use it consistently.